but prophesy that the future is more than hopeful, now that the public is beginning to be educated in education. It will demand, and its wants will be supplied.

APPENDIX.

Number of Schools of Science and their Grants.

Year	Higher Grade Schools	Endowed Secondary Schools	Technical Institutes	Total Schools	Total Grants
					£
1895	53	30	29	112	39,163
1898	69	50	49	168	98,849
1901	63	106	43	212	118,833
1903	50	119	57	226	Not yet known[1]

Number of Schools teaching Shortened Course of Science.

Year	No.
1902	127
1903	184

Number of Laboratories recognised.

Year	Chemistry	Metallurgy	Physics	Biology	Mechanics
1880	133	—	—	—	—
1900	669	37	219	17	4
1901	722	37	291	26	10
1902	758	39	320	34	14

Grants paid for Science Instruction.

Year	Amount	Year	Amount
	£		£
1860	709	1890	103,453
1870	20,118	1895	142,543
1875	42,474	1901	212,982
1880	40,229	1902	240,822
1885	63,364		

THE GERMAN ASSOCIATION AT CASSEL.

THE seventy-fifth meeting of the German Association for the Advancement of Science and Medicine took place in brilliant weather in the picturesque town of Cassel. By Saturday evening, September 19, members and associates began to arrive, and on Sunday a large number of gaily coloured "rosettes" were visible in the streets. Advantage was taken of this gathering of men of science to present to Prof. Graebe, of Geneva, an address on the completion of the twenty-fifth year of occupancy of his chair of chemistry, and M. Moissan, of Paris, on behalf of the Chemical Society, conveyed to him the Lavoisier medal of the Institute of France. Prof. Graebe, who, in conjunction with Prof. Liebermann, of Berlin, achieved the first important chemical synthesis—that of artificial alizarine—was an old assistant of Prof. v. Baeyer, of Munich, who then occupied the chair of chemistry in the Gewerbe Akademie in Berlin. Prof. v. Baeyer, in his opening address, directed special attention to the cooperation of men of science with technologists, which was the fruit of this important synthesis—a cooperation which has had enormous influence on the development both of German science and industry. The rector of the University of Geneva followed, and he mentioned that, during the twenty-five years of Prof. Graebe's tenure of the chair, he had published 196 memoirs on chemical subjects, while more than 400 papers were published by workers in his laboratory. Prof. Moissan, who, as delegate of the Académie des Sciences, handed to Prof. Graebe the Lavoisier medal, referred in an eloquent speech to the great influence which Graebe's work has had in developing synthetical organic chemistry, and after the presentation of addresses from the Royal Academy of Sciences of Bavaria, from the German Chemical Society, from the Societies of Geneva and Frankfort, and from the University of Lausanne, Prof. Graebe received from the chairman a gold plaque, engraved with his portrait, and from M. Amé Pictet, on behalf of his old students, a bound copy of his own papers. Dr. Brunck, on behalf of the "Badische" Chemical Company, of which he is managing director, added a tribute to Graebe from the point of view of technology, and in an eloquent reply Prof. Graebe expressed his gratitude and thanks. About sixty of the audience remained to a dinner given in honour of Prof. Graebe, at which numerous toasts were drunk, and the proceedings were kept up until a late hour.

[1] In 1902 124,300*l.* was paid.

The members and associates met for the first time on Sunday evening, September 20, in the grounds of the Hessian Brewery, where a large hall had been adapted for the purpose of the general meetings, and on Monday morning, after words of welcome from Prof. Hornstein, of Cassel, the local secretary, from President von Trott zu Solz, from the mayor and others, the president of the Association, Prof. van 't Hoff, returned thanks in the name of the Association. An address was then delivered by Prof. Ladenburg on the influence of science on our views of life. The address treated of the gradual development of scientific knowledge and its opposition by the church; the necessity of education in the phenomena and laws of nature, and the insignificant position of man among natural phenomena; the doctrine of the immortality of the soul and the dicta of science on the subject. He contended that Christianity alone had been unable to induce mankind to accept the doctrine of liberty, equality, and fraternity, and that this doctrine, indispensable for our future progress, must be the future object of scientific endeavour. The general opinion of the audience appeared to be that Prof. Ladenburg's address was unnecessary, and that he had assumed for science an infallibility similar to that claimed by the Apostolic See. The second address, by Prof. Ziehen, of Utrecht, treated of impressions and sensations, and their connection with the surface of the brain. Sensations may be termed positive or negative, according as they produce pleasant or unpleasant emotions, and their intensity depends less on the degree of excitability of the regions of the brain affected than on the capacity for "discharge" or communication with other regions. "Negative" sensations are more numerous than positive; the lecturer attempted to prove this by the fact that, in German, words denoting unpleasant are more numerous than those which denote pleasant sensations. But up to now it had been impossible to bridge the gap between the mechanism of the brain and the sensations and perceptions.

In the afternoon the sections met, and in the evening the opera of "Tannhäuser" was well performed in the theatre. September 21 was devoted to sectional meetings, and in the evening the members and associates dined together in the "Festhalle," and many toasts were proposed. On the morning of the next day addresses were delivered by Prof. Penck, of Vienna, on geological time; by Prof. Schwalbe, of Strassburg, on the early history of man; and by Dr. Alsberg, of Cassel, on inherited degeneration as a consequence of social influences. On the morning of September 24 the medical side of the congress was represented by Dr. Allan Macfadyen, who gave an address on intercellular toxines; by Dr. Paul Jensen, on the physiological action of light; and by Dr. Rieder, on the curative results obtained by treatment with light.

Later in the morning, in order to open a discussion on the place of mechanics in our views of nature, papers were read by Dr. Schwarzschild, of Göttingen, on astronomical mechanics, by Prof. Sommerfeld on technical mechanics, and by Prof. Otto Fischer on physiological mechanics. Dr. Schwarzschild began by stating that Newton's law of gravitational attraction still remains the leading factor in astronomy, and every observation only serves as a confirmation of its correctness. It has been proved to be correct to two parts in one hundred millions. The chief aim of astronomical mechanics is to represent exactly the actual path of the planets. But the classical "Mechanics of the Heavens" fails, if it is applied to very long periods of time. The formulæ which are applied would, if extended, point to a destruction of the planetary system. There are, however, two reasons for believing that such a conclusion would be incorrect. The problem of "secular disturbances" was solved by Lagrange, and that of "commensurabilities"

has made great progress during the last thirty years. Under the last head may be grouped periodic and asymptotic paths, the problem of the gaps in the asteroids and the ring of Saturn, and the theory of the libration of the moons of Jupiter and Saturn. When these are carefully considered, they appear to point to the stability of the planetary system for all time. This conclusion is, indeed, rendered less general by Poincaré's proof of the divergence of series in the theory of disturbances, but it can nevertheless be shown that, during a long period of time, for which it is possible to give a lower limit, changes in the planetary system are unimportant. The problems which still face the astronomer who undertakes similar investigations were exemplified by Lexell's comet and Darwin's periodic paths.

Prof. Sommerfeld, in indicating the direction in which mechanics comes into technical use, spoke of the confirmation of experimental principles and the greater use of theory. He gave an account of the teaching of mechanics in the universities and Polytechnika of Germany, entering somewhat into detail as regards the order of presentment of various conceptions. Dr. Otto Fischer discussed the necessity of determining the dimensions, the mass, the centre of gravity, and the moment of inertia of various portions of the living body, and the effects of external and internal forces in altering these properties.

On the morning of September 25 Sir William Ramsay lectured on the periodic system of the elements, Prof. Griesbach on school hygiene, and Prof. von Behring on the fight against tuberculosis. Ramsay spoke of the various attempts which have been made to ascertain whether mass and inertia, on the one hand, are invariable, or, on the other, whether the atomic weights show signs of variation. On the whole, the evidence is negative. He then described the spontaneous change of the emanation from radium bromide into helium, and concluded with some speculations as to the possible formation and decomposition of what are at present regarded as elementary bodies. The subject of school hygiene, though a very important one, has little scientific interest, but the lecture of von Behring was listened to with the greatest attention. Prof. von Behring has a large estate at Marburg where experiments on tuberculosis are carried out on animals. For example, he has rendered it very probable that vaccination of cows with the tuberculosis antitoxin renders their milk immune, and that the milk, in its turn, may render human beings immune. He believes to have shown that infants acquire tuberculosis through milk, and that even before birth the skin of infants is penetrable by the tubercular bacillus. If such infants are nourished on the milk of cows which have been injected with tubercular bacillus, the milk contains an antitoxin, and the tendency towards tuberculosis is obviated. He advocated the view that adults seldom acquire tuberculous diseases unless they are early predisposed to receive them by infection as infants. But this tendency can be combated by feeding infants with milk from cows which, through vaccination with tubercular matter, have developed the suitable antitoxin.

Prof. van 't Hoff, the president of the Association, then concluded by giving a short account of the most important papers which had been communicated to the sections, after which he thanked the town of Cassel, in the name of the Society, for its hospitable reception.

The German "Naturforscherversammlung," unlike the British Association, includes many sections which treat of medical subjects. Only those lectures which are of general interest are delivered before the Association as a whole. The proceedings of the medical sections will doubtless find their way into the medical journals, and only the proceedings of scientific interest will be treated of here. Through the courtesy of the president and of Prof. Rassow, of Leipzig, abstracts of the more noteworthy of the papers in each section were furnished to the writer.

Of the mathematical section, it was merely stated that in all five meetings were held, in which twenty-eight papers were read, three being of some length. It would appear that mathematicians are too modest to thrust their views on the scientific brethren, or perhaps they doubt if they would be understood.

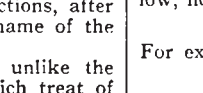
The most noteworthy papers in the physical section were, first, a confirmation by Prof. Rubens of Maxwell's theory by experiments on the optics of metals—their refractivity, and behaviour to electric currents; and, second, a paper by Prof. Nernst, in which he described and showed his iridium apparatus, by means of which a temperature of 2000° C. has been attained, and determinations of vapour density carried out. Nernst's "furnace" consists of an iridium tube about 10 inches long and 1½ inches diameter. By means of a powerful current which passes through the walls of the tube the temperature can be raised to any desired degree, short of the melting point of iridium. A small "bulb" of iridium, similar to that used for Victor Meyer's density apparatus, hangs inside the tube, and attains the temperature of the iridium tube. Nernst's balance, by means of which a couple of milligrams of substance can be correctly weighed to within a half per cent., consists of a glass fibre suspended by a quartz fibre at right angles to it; from one end hangs a small iridium capsule counterpoised by a small weight; the other end of the glass fibre projects over a mirror-scale; the balance acts partly by torsion of the quartz fibre, partly like a steelyard. The density of vapours of "non-volatile" substances is determined exactly as with a Victor Meyer apparatus, and while that of sulphur was found to correspond to S_1, that of phosphorus gave negative results in an atmosphere of nitrogen, due, no doubt, to the formation of a compound of phosphorus with nitrogen, stable only at a high temperature. Nernst also described his method of measuring high temperatures by noting the intensity of the radiation from the interior of the tube.

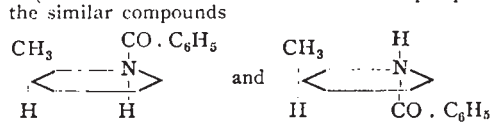
In the section of applied mathematics, Dr. Otto Thilo spoke of the necessity of a knowledge of mechanics for the investigator. By help of preparations and models he demonstrated the relation of sinews to bones, especially those which confine the motion to one plane, the mechanism for getting over the "dead-point," and those for restraint, so that muscular power is saved, for example, when a man is standing erect. He further went on to demonstrate the mechanism by which the pressure of air in the swimming-bladder of fishes is communicated to the brain. His contention was that even biologists must be instructed in mechanics if they wish to study the movements of living organisms.

In the chemical section, Prof. Biltz spoke about the precipitation of colloids by salts. He advanced the theory that a colloidal solution consists of a colloid suspended in an electrolyte; when a precipitant is added a new form of combination occurs, for instance:—

Electrolyte − colloid + colloid-precipitant =
colloid − colloid-precipitant + electrolyte.

The precipitation of the iodine-starch substance by means of alumina was illustrated, and also of the meta-phosphoric acid-albumen couple. Prof. Ostwald suggested that the precipitation depends on the relative velocity of the two reactions, and that that reaction which takes place most rapidly gives rise to the formation of stable substances. Prof. Wedekind showed isomeric organic ammonium salts containing radicals of high molecular weight, and Prof. Ladenburg also read a paper on asymmetric nitrogen. Prof. Wallach mentioned a new instance of optical isomerism, in which, if the molecular weight of the substituting group is low, no isomerism is noticeable, but if high, isomerism exists.

For example, the compound  gives us isomerides (the benzene nucleus is here seen in perspective), while the similar compounds



are isomeric.

Prof. Nernst read a paper on the theory of ozone formation. The potential difference between the system O_3, O_2|electrolyte|O_2 is 0·57 volt, and this corresponds with the heat of formation of ozone, for the couple has practically no temperature-coefficient. He calculated that if oxygen is heated to 6400° it should contain 10 per cent. of ozone, at 3230° 1 per cent., and at 2183° 0·1 per cent. In the sun the oxygen must be wholly in the state of ozone, owing to the high temperature and the enormous gravitational pressure. Prof. Abegg spoke of two cases of heterogeneous

equilibrium, and other papers treated of the ring formula for benzene, the use of the spectroscope in the determination of atomic weight (Runge), fluorescence and chemical constitution (Richard Meyer), &c.

In the section of applied chemistry, Prof. König spoke of the determination of fibre, cellulose, and lignin in plants, and of the decomposition of fodder by microbes, and Dr. Marquart, of Cassel, gave an account of Dr. Schenck's red-phosphorus. This variety is produced at a comparatively low temperature—about 180°—by heating a solution of yellow phosphorus in phosphorous bromide. It is precipitated out of the solution, and must be filtered off and washed with carbon disulphide to free it from yellow phosphorus. Its point of inflammation is that of ordinary red phosphorus, but it is in a state of such fine division as to be readily set on fire by rubbing if it be mixed with potassium chlorate; at the same time it gives off no fumes, and is therefore harmless to operatives who dip matches. The light red powder is soluble in caustic soda (for it probably contains an atom of replaceable hydrogen), and is reprecipitated by acids. Dr. Marquart spoke especially of the future of this substance in the manufacture of matches which ignite when rubbed on any surface, and which, at the same time, are without danger to workpeople.

In the section of geophysics, Dr. Mansing exhibited an apparatus for determining the ebb and flow, and also the direction and velocity, of currents, and likewise the pressure in deep water. The apparatus is electrically connected with a ship, and registers for thirty days. The advantage over apparatus which registers only in shallow water is obvious. Dr Nippolt read a paper on terrestrial magnetic variations, citing observations made partly by himself, but mainly by others. The curves which he obtained point to changes which occur simultaneously at different spots of the earth's surface; he interprets such changes as significative of changes in the internal nucleus of the earth, and of displacements of the relative positions of the earth's crust and the magma which he believes to exist in the interior. Prof. Krebs treated of subaqueous volcanic regions, and suggested that they may be points of connection between the sea-water and the earth's internal magma; he advocated that their position and nature deserve careful investigation on account of danger to passing ships. In another paper Dr. Krebs believed he had found an explanation of the inundations in Silesian Austria, in certain long areas of low barometric pressure from which regions of low pressure in Silesian Galicia can be deduced.

Dr. Wolkenhauer, in the geographical section, spoke of the oldest German maps, which he ascribed to the fifteenth and sixteenth centuries. The oldest maps are by Erhard Etzlaub; those of Cuza, which were formerly believed to have been published in 1491, appear to be as late as 1530. The attendance in this section was very small, owing to the meeting this year of geographers at Cologne.

In the botanical section the most important papers were by Prof. Kohl, who offered a proof that the central bodies of the Cyanophyceæ cells possess the properties of cell nuclei, and he expressed the belief that in the closely allied Schizomyceteæ a similar proof could be found. Numerous experiments on Mycorrhizen, an account of which was given by Prof. Möller, proved that the existence of fungi on the roots of plants must be regarded as a case of parasitic existence, but not of symbiosis. Prof. Drude, who has made numerous experiments in the botanic garden at Dresden, contended that mutation cannot be sharply distinguished from variation, as De Vries believes, but that the difference is only one of degree. To prove his contention, he exhibited living specimens of *Oenothera Lamarckiana*, grown from seed which De Vries had given him.

In the zoological section only one meeting was held, at which lectures were delivered by Prof. Klunziger, Dr. Thilo, Dr. Eysell, and Dr. Basse. They were illustrated by demonstrations, but appear not to have contained any specially new matter.

The anthropological section excited a good deal of interest. Among the more important papers was one by Prof. Hagen, in which he demonstrated that the eight months' fœtus of the Malay and Melanesian races differed from the European fœtus by the shortness of the body compared with the limbs, and the greater diameter of the body in the region of the false ribs, &c. The Melanesian fœtus showed peculiarities from which he deduced the conclusion that the genus man became differentiated from other mammals at a very early period of history. On the other hand, Prof. Schwalbe, from investigation of the frontal sutures of apes and their comparison with those of man, contended that there is a close relationship to be observed between man and old-world apes. Prof. Gojanovic-Kramberger had examined human remains recently discovered in Croatia—the so-called *Homo crapinensis*—and concluded from his researches that in the Ice age two races were alive; the differences in the form of the jaws and teeth, the shape of the collar-bone, the upper arm and parts of the skull, were adduced as proof of his view. One of these races, he believed, showed analogy with the owner of the Neanderthal skull and the skeleton from the grotto of the Spy, so far as the morphological relationship could be traced.

One of the sections dealt with the teaching of mathematics and science in schools, and there Prof. Grimsell demonstrated the use of new apparatus designed to illustrate terrestrial magnetism and the mechanical equivalent of heat, and he showed a lantern which gave good images with an ordinary incandescent gas flame. Prof. Schotten gave a lecture which was largely attended, and at which much discussion took place on the suitability of zoology as a school subject. While most of the speakers agreed on its being easily taught and useful, doubt was expressed whether it was wise to add another subject to the already heavy load which a German boy is expected to carry. On the whole, the latter opinion was the more widely held.

After the meeting the members made excursions to objects of interest in the neighbourhood of Cassel. About seventy chemists and physicists visited Göttingen and inspected the laboratories of Profs. Nernst, Voigt, Rieke, and Wiechert; the last has been created only a few years, and is devoted to the investigation of the problems of "terrestrial physics." It is furnished with seismographs, instruments for investigating terrestrial magnetism, atmospheric electricity, &c., and good work is already being done in it. It is a handsome building at some distance from the town, and it may be held up as an example of the way in which the Germans leave no stone unturned to be first in the investigation of natural phenomena of all kinds. Some of the associates, chiefly medical, visited Marburg, in order to inspect Prof. von Behring's institute for the study of tuberculosis. The buildings and equipment must be characterised as magnificent. Here, again, is an instance of the cooperation of the scientific man and the manufacturer, for Dr. von Behring was for long scientific adviser to the firm of Höchst, which erected the laboratories, and undertook the manufacture of the antitoxin serum. Would that a similar spirit of cordial cooperation between English men of science and "practical" men could become more common.

W. R.

FORTHCOMING BOOKS OF SCIENCE.

MR. F. ALCAN (Paris) gives notice of:—"Essai sur le Langage intérieur et la Fonction endophasique à l'État normal et dans les États pathologiques," by Dr. G. Saint-Paul; "Travail et Plaisir," by Dr. Ch. Féré; "La Philosophie pratique de Kant," by V. Delbos; "Manuel d'Histologie pathologique," by Cornil, Ranvier, Brault et Letulle, Tome iii.; "Mécanisme et Éducation des Mouvements," by G. Demeny; "Les Défenses de la Vie," by Dr. J. Laumonier; "Histoire de l'Habillement et de la Parure, depuis les Temps préhistoriques jusqu'à nos Jours," by L Bourdeau; "Traité de Sylviculture—Exploitation et Aménagement des Bois," by Prof. P. Mouillefert; "L'Éducation," by C. A. Laesant."

Mr. George Allen promises:—"Ideals of Science and Faith," nine essays by Sir Oliver Lodge and various other writers, edited by Rev. J. E. Hand.

Mr. Edward Arnold's announcements include:—"The Chemical Synthesis of Vital Products and the Interrelations between Organic Compounds," by Prof. R. Meldola, F.R.S.; "The Strength and Elasticity of Structural Members," by R. J. Woods: "The Evolution Theory," by Prof. A. Weismann, translated by Prof. J. A. Thomson, two volumes, illustrated; "Nature Study," by